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1. Flight Preparations

As mentioned in the preceding progress report all sub-assemblies of Stratoscope II, as well as the Stratoscope Group from the Perkin-Elmer Corporation, had arrived at the Balloon Base in Palestine, Texas at the end of April. The Princeton Group moved to Palestine at the start of June. The assembly of the instrument and its testing went as a whole in an entirely satisfactory way though the accumulation of a number of minor difficulties necessitated the postponement of the flight readiness date by twelve days, to July 10th.

The entire pointing mechanism with its various mechanical, optical and electronic sub-assemblies went through its extensive sequence of tests wonderfully trouble-free. The same was true for the TV cameras and trans-

mission links tested by the RCA engineers. The nastiest of the delaying difficulties was the fact that one of the invar buttons glued to the primary mirror and used for the gravity-balanced suspension of the mirror, was found to have separated from the quartz blank; it turned out that the original glue had deteriorated and that all the buttons used in tension had to be reglued. The refrigeration mechanism (needed to pre-cool the primary mirror to stratospheric temperatures prior to launch) required more adjustments and testing than had been expected but eventually performed satisfactorily even during the extremely hot days of the standby and flight period.

In the preparation of the entire balloon system no serious difficulties were encountered by the Stratoscope Group of the Vitro Laboratories.

2. Scientific Flight No. 4

The final pre-launch test of the entire instrument, as well as the start of the refrigeration period were accomplished on schedule and the ground station caravan moved to Gatesville, Texas on July 9 for the standby period; from there the ground station could be moved and setup on a pre-selected lonesome hill (about 150 miles west of the launch base) on about four hours notice.

On the very first readiness day, July 10th, the weather was favorable and the launch operations were set into action. Everything went smoothly until the end of the inflation period when it was found that the necessary gross lift could not be reached. The reason for this failure was soon discovered: a fixture attached to the top balloon and used in conjunction with the doughnut handling lines had become wrapped in some of the loose folds of the balloon and then had torn a rip into the balloon material, thus

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causing a severe helium leak that was not repairable right then. Accordingly, the launch had to be called off for that day.

The spare top balloon was integrated into the balloon system in record time and the fixtures, one of which had caused the inflation failure, were replaced by safer ones. Everything was flight ready again for July 13.

During the next three days a launch was impossible because of a persistent danger of sudden thunder storms. This difficulty, characteristic for balloon launches in the late afternoon during the summer months in the South, had been well foreseen and elaborate preparations had been made in advance. Special analyses specifically directed towards this problem and steadily executed by the U.S. Weather Bureau Meteorologists stationed at the Balloon Base, a regular daily sequence of telephone conversations with the U.S. Weather Bureau Center at Kansas City, special radio sonde/runs carried out by the NCAR base crew, and last but not least the persistent use of the local NCAR weather radar, all helped substantially to overcoming this problem. Nevertheless, it was a most harrassing one. Attempts to forecase the thunderstorm probability for a given afternoon as early as the evening before turned out impractical and even the forecast during the early morning of the very day were still normally, by the nature of the problem, seriously uncertain. In consequence, practically each day all launch preparations had to be carried through until nearly 2:00 p.m. when essentially the final go or no-go decision had to be made. Only an extra conservative attitude in the decision making procedure resulted in the fortunate circumstance that no damage was encountered from being caught in a sudden thunderstorm.

On the afternoon of July 15 it was discovered that a minute leak in the refrigerated chamber surrounding the primary mirror had permitted (in spite of a steadily maintained slight superpressure in the chamber) water condensation to penetrate into the chamber and form by and by some ice on the field lens at the F20 focal plane contained within the chamber. In consequence, the flight

had to be called off for the next day (luckily the weather was not good either), the whole primary mirror chamber had to be warmed up, and de-humidified, the leak sealed, and the refrigeration re-started. The instrument was again flight-ready for July 17. Then followed six more days in which winds or thunderstorm danger prevented a launching. On July 22nd after the launch had been definitely called off for that date at 1:30 p.m., the ground station returned from Gatesville to the Balloon Base and a test of the telescope, which by now had stood by for two weeks since the last pre-launch test, was carried through. The entire instrument to the degree that it could be tested without disengaging the refrigeration system and lifting the telescope from the launch vehicle, behaved perfectly. The ground station returned to Gatesville that evening.

On the next day, July 23, the weather behaved uncertain all during the morning (while, like on all the preceding days, the preliminary launch operations were carried out), but cleared up just in time for the critical go decision. This time all the inflation and launch operations went entirely smoothly. Only the disengagement of the refrigeration system from the telescope, including the starting of the flow of cold acetone through one of the cooling coils within the mirror cell, was somewhat hectic; this operation was carried out here for the first time under actual flight conditions.

At the Ground Station the balloon was acquired through the various radio links soon after launch and the different electronic systems were turned on in sequence according to plan. While the balloon was reaching altitude the automatic unlatching sequence was initiated. The telemetry signals indicated proper function of each step of the sequence until the very end when it became clear that the last step, the opening of the upper latch, had malfunctioned. There followed five miserable hours in which the entire Ground Station crew strained all their talents towards overcoming this failure. A large number of

remote control tests were carried out and all possible relevant combinations of direct and emergency commands were given with the hope of opening the upper latch and thus leaving the telescope free for scientific operations. Nothing worked. However, a fairly complete picture of the electronic state of the instrument and even a partial picture of the mechanical state of the instrument with regard to the failure was obtained. The last hours of the night were devoted to testin g all the other sub-systems, not involved in the one specific failure, to the degree that they could be tested in the latched position; not a single other malfunction was uncovered.

By sunrise the control over the balloon system was returned to the Vitro Balloon Control Group, who immediately initiated the descent. A malfunction of a micro switch essential for the reclosing of the helium valve made it impossible to keep the descent rate of the balloon within the tolerable limits and it was necessary after some time to separate the parachutes from the balloon system and letting the telscope descend on the parachutes. Apparently the separation of the parachutes from the balloon occurred in unusually unfavorable circumstances causing high transi t forces. One of the consequences of this circumstance was that one of the two parachutes was somewhat damaged and accordingly the telescope descend speed was somewhat higher than it should have been leading, to the best of our analysis, to a slightly increased landing damage. A second potentially more serious consequence of this abrupt event was that the balloon control instrument box tore free from the balloon which made it impossible to give the balloon distruct command. Luckily the balloon descended by itself before nightfall. The recovery of the telescope which landed in an open prairie field presented no difficulties and it was shipped directly back to the Perkin-Elmer Plant.

3. Post Flight Analysis

The search for the concrete cause of the unlatching failure was begun right at the landing site by detailed inspections and photographs, and then continued at the Perkin-Elmer Plant as soon as the instrument arrived there. This highly successful technical detective work of the Perkin-Elmer crew led to the convincing conclusion that the basic failure had not occurred in the latch itself but rather in the ascent cooling system (shown here for the first time). Clear evidence was found that a substantial amount of the acetone, all of which was supposed to run out of its container through the primary cell cooling coil during the first hour of the ascent, had not done so (presumably by an icing up of the outlet valve), but was still in its original container on landing; clear traces of splashes of acetone caused by the landing impact were found on the upper portion of the telescope tube. The presence of this acetone all during the flight caused such a heavy unbalance of the telescope that the upper latch, by design, could not open.

Thereafter detailed design plans were developed to overcome the weakness that had led to the unlatching failure, but also to increase the reliability of the number of subsystems of Stratoscope II, particularly in the mechanical area, in the spirit of using the occurrence of the specific, though single failure during the last flight as an impetus to increase the overall reliability of the instrument. At the same time plans were developed for some slight modifications in the balloon inflation instrumentation to decrease the probability of the occurrence of an inflation failure such as had happened on July 10. Similarly the design of a new independent balloon destruct mechanism was being planned.

All these plans were presented to the sponsors in Washington on September 7, and this presentation was written up in the form of a detailed status report of the project, dated October 7, and distributed to the sponsors soon thereafter.

By the end of this report period the repairs and improvements of Stratoscope II are well underway and it appears likely that the instrument can be shipped to the Balloon Base in Palestine by mid-January making a new flight in mid-April probable.

4. Scientific Research

Dr. Jason Auman's research on the opacity of water vapor at temperatures and pressures relevant for the red giant stars observed with Stratoscope II in the infrared on the second flight has reached the state in which he can give definite opacity curves as a function of wavelengths for most of the wavelength range relevant for these stars. The results are unexpected in the sense that for these cool stars the water vapor opacity appears to be even more dominating than had been guessed after the deep and broad water vapor bands had been found in the infrared spectra obtained in the second flight. At the temperatures of the atmospheres of the cool red giant stars the wings of the water vapor bands spread so far that even in the wavelength regions between the main parts of the bands the water vapor opacity appears to dominate all other opacity sources. The completion of the determination of these opacities which involves the analysis of over two million lines (by an electronic computer) will still take at least three months. After this specific research phase is finished it is planned to use the new opacities for the construction of theoretical model stellar atmospheres which then can be directly compared with the Stratoscope infrared results.

Dr. R. Wattson of the Princeton Stratoscope Group, together with Dr. B. Hapke of Cornell University, has measured the infrared albedo of sands produced by grinding up certain rocks plausible to constitute the surface of the moon. Prior to the measurements these sands were irradiated by fast

protons imitating the radiation suffered by the surface of the moon. Similar measurements in the visual wavelength range by Dr. Hapke had indicated good agreement with the visual measurements on the moon. The same type of satisfactory agreement was found in this new investigation when the laboratory results were compared with the lunar albedo in the infrared as measured during the second flight of Stratoscope II.